

What is claimed is:

1. A method for manufacturing an optical demultiplexer on an integrated circuit substrate for wavelength division transmission of information, comprising:
  - fabricating an array of optical detectors on the substrate based on a predetermined optical detector design analysis;
  - fabricating a signal conditioning circuit on the substrate adjacent to the array of optical detectors and coupling the signal conditioning circuit to the array of optical detectors;
  - forming a first layer of optically transparent material on the substrate covering the array of optical detectors and signal conditioning circuit;
  - fabricating a binary blazed grating on the first layer of optically transparent material; and
  - forming a second layer of optically transparent material over the first layer and binary blazed grating to form an optical waveguide for diffracting incident light.
2. The method for manufacturing an optical demultiplexer of claim 1 wherein a thickness of the first layer of optically transparent material is determined based on a specific application for the optical demultiplexer.

3. The method for manufacturing an optical demultiplexer of claim 1 wherein the array of optical detectors is formed on a silicon P-I-N structure.
4. The method for manufacturing an optical demultiplexer of claim 3 wherein the array of optical detectors is formed by removing a silicon dioxide layer from the “N” regions of the substrate, forming a trench in the “N” regions and filling the trench with “N” type doped polysilicon.
5. The method for manufacturing an optical demultiplexer of claim 4 wherein the step of forming a trench in the “N” regions is performed via inductive coupled plasma etching.
6. The method for manufacturing an optical demultiplexer of claim 4 wherein the step of filling the trench with “N” type doped polysilicon is performed via a low-pressure chemical vapor deposition process.
7. The method for manufacturing an optical demultiplexer of claim 6 further comprising the step of removing “N” type doped polysilicon from the silicon dioxide layer.
8. The method for manufacturing an optical demultiplexer of claim 3 wherein the array of optical detectors is formed by removing a silicon dioxide layer from the

“P” regions of the substrate, forming a trench in the “P” regions and filling the trench with “P” type doped polysilicon.

9. The method for manufacturing an optical demultiplexer of claim 8 wherein the step of forming a trench in the “P” regions is performed via inductive coupled plasma etching.
10. The method for manufacturing an optical demultiplexer of claim 8 wherein the step of filling the trench with “P” type doped polysilicon is performed via a low-pressure chemical vapor deposition process.
11. The method for manufacturing an optical demultiplexer of claim 10 further comprising the step of removing “P” type doped polysilicon from the silicon dioxide layer.
12. The method for manufacturing an optical demultiplexer of claim 1 wherein a length for each optical detector is determined based on a predetermined output optical pattern from the binary blazed grating.
13. The method for manufacturing an optical demultiplexer of claim 1 wherein the step of forming a first layer of optically transparent material comprises depositing

a material having a low index of refraction on the substrate and the array of optical detectors formed on the substrate.

14. The method for manufacturing an optical demultiplexer of claim 13 wherein the deposited material is selected from a group consisting of a polymer or silica.
15. The method for manufacturing an optical demultiplexer of claim 13 wherein the deposited material has an index of refraction from about 1.0 to about 2.0.
16. The method for manufacturing an optical demultiplexer of claim 1 wherein the step of forming a second layer of optically transparent material comprises depositing a material having an index of refraction that is greater than the index of refraction of the first layer of optically transparent material.
17. The method for manufacturing an optical demultiplexer of claim 1 wherein the step of forming a second layer of optically transparent material comprises depositing a material having an index of refraction that is different from the index of refraction of the first layer of optically transparent material.
18. The method for manufacturing an optical demultiplexer of claim 16 wherein the deposited material is selected from a group consisting of silicon nitride, a polymer, silica, silicon, polysilicon or LiNbO<sub>3</sub>.

19. The method for manufacturing an optical demultiplexer of claim 1 wherein the incident light comprises a plurality of beams each having a different and discrete wavelength.
20. The method for manufacturing an optical demultiplexer of claim 1 wherein the incident light originates from a device on the integrated circuit substrate.
21. The method for manufacturing an optical demultiplexer of claim 1 wherein the incident light originates from outside the integrated circuit substrate.
22. The method for manufacturing an optical demultiplexer of claim 1 wherein the binary blazed grating diffracts the incident light into a plurality of component beams of discrete wavelengths that are intercepted by a corresponding optical detector in the array of optical detectors.
23. The method for manufacturing an optical demultiplexer of claim 1 wherein the binary blazed grating comprises a plurality of ridges and a plurality of troughs, the width and the spacing of the ridges and troughs being varied during fabrication to provide a plurality of localized subwavelength, submicrometer grating features within a grating period.

24. The method for manufacturing an optical demultiplexer of claim 1 wherein the step of fabricating a binary glazed grating on the first layer comprises the steps of designing a hard mask for the binary blazed grating through a simulation.
25. The method for manufacturing an optical demultiplexer of claim 24 wherein the step of fabricating a binary blazed grating further comprises patterning the hard mask on the first layer of optically transparent material and etching the binary blazed grating.
26. The method for manufacturing an optical demultiplexer of claim 1 wherein the step of forming a second layer of optically transparent material is performed via a low-pressure chemical vapor deposition.
27. The method for manufacturing an optical demultiplexer of claim 1 further comprising the step of planarizing the second layer of optically transparent material.
28. The method for manufacturing an optical demultiplexer of claim 1 further comprising forming the optical waveguide using a conventional planar light circuit process to manipulate the path of the incident light.

29. The method for manufacturing an optical demultiplexer of claim 1 further comprising exposing a plurality of contact pads of the signal conditioning circuit via lithography and etching.
30. The method for manufacturing an optical demultiplexer of claim 1 further comprising placing interdigitated electrodes on each optical detector during fabrication of the signal conditioning circuit.
31. A method for manufacturing an optical multiplexer on an integrated circuit substrate for combining light beams of discrete wavelengths into a single polychromatic beam for wavelength division transmission of information, comprising:
- positioning an array of optical emitters on the substrate;
  - fabricating a signal conditioning circuit on the substrate adjacent to the array of optical emitters and coupling the signal conditioning circuit to the array of optical emitters;
  - forming a first layer of optically transparent material on the substrate covering the array of optical emitters and signal conditioning circuit;
  - fabricating a binary blazed grating on the first layer of optically transparent material; and

forming a second layer of optically transparent material over the first layer and binary blazed grating to form an optical waveguide for intercepting light beams of discrete wavelengths and combining the intercepted light beams into a polychromatic light beam for transmission through the optical waveguide.

32. The method for manufacturing an optical multiplexer of claim 31 wherein the step of forming a first layer of optically transparent material comprises depositing a material having a low index of refraction on the substrate and the array of optical emitters formed on the substrate.
33. The method for manufacturing an optical multiplexer of claim 31 wherein the deposited material is selected from a group consisting of a polymer or silica.
35. The method for manufacturing an optical multiplexer of claim 19 wherein the step of forming a second layer of optically transparent material comprises depositing a material having an index of refraction that is greater than the index of refraction of the first layer of optically transparent material.
37. The method for manufacturing an optical multiplexer of claim 31 wherein the step of forming a second layer of optically transparent material comprises depositing a



material having an index of refraction that is different from the index of refraction of the first layer.

38. The method for manufacturing an optical multiplexer of claim 31 wherein the deposited material is selected from a group consisting of silicon nitride, a polymer, silica, silicon, polysilicon or LiNbO<sub>3</sub>.
39. The method for manufacturing an optical multiplexer of claim 31 further comprising fabricating the binary blazed grating on the first layer of optically transparent material.
40. The method for manufacturing an optical multiplexer of claim 31 further comprising fabricating the binary blazed grating on the second layer of optically transparent material.